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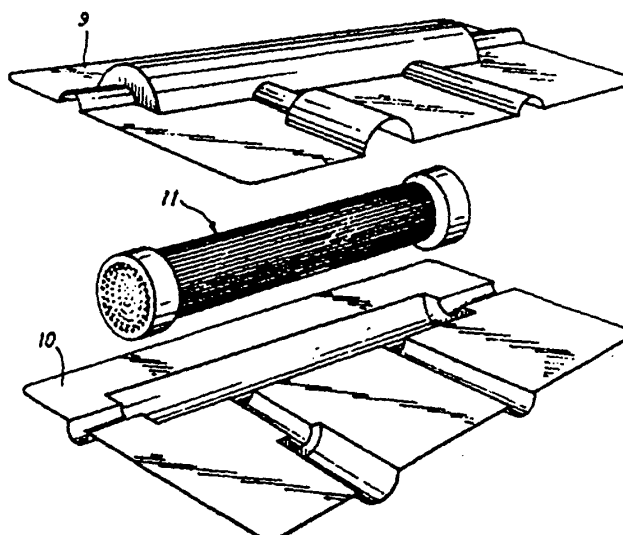
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**Published**

With international search report.

(54) Title: MEMBRANE FILTER UNIT AND PROCESS OF PRODUCING SAID UNIT

**(57) Abstract**

There is described a membrane unit wherein at least two outer casing portions are sealed together around a membrane. The unit is desirably formed from a process whereby the two outer casing portions are provided, a membrane is located within the casing and said casing portions are sealed together, advantageously with a blue light or UV light curing adhesive. The membrane may be in the form of hollow fibre(s) and a preliminary step involving the formation of a plug of adhesive around the fibre may be present in the process. The set plug of adhesive may be trimmed and then placed into the outer casing portions for sealing therein.

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1   "Membrane Filter Unit and Process of Producing said  
2   Unit"

3  
4   The present invention is concerned with a process for  
5   producing sealed units which comprise a membrane  
6   barrier and the units produced by that process.

7  
8   Sealed membrane units are desirable for many purposes  
9   which require a filtration step. Generally, the  
10   membrane is sealed into the unit in such a way that the  
11   mother liquor (liquid to be processed) is separated  
12   from the filtrate by the membrane. Where the membrane  
13   unit is to be used for medical purposes for example  
14   dialysis, it is of course particularly important for  
15   the unit to be sealed completely and for the membrane  
16   to be clean, preferably sterile.

17  
18   Currently sealed membrane units of this type are formed  
19   using a one-part (generally tubular) outer casing. The  
20   membrane fibres are threaded through the outer casing  
21   and the ends of the membrane are then fixed in place by  
22   adhesive. The adhesive is introduced into the outer  
23   casing and the whole unit is spun, so that the  
24   centrifugal forces created cause adhesive to locate at  
25   each end of the outer casing. The adhesive is then

1 allowed to set. However, this procedure is time  
2 consuming and the need to spin the units requires  
3 expensive machinery to ensure adequate results.  
4 Moreover, it cannot be guaranteed that an adequate seal  
5 will be produced at each end of the unit so that  
6 careful testing of each unit is required. In addition,  
7 the ends of the hollow fibre membranes frequently  
8 become blocked by adhesive during the spinning process.

9  
10 The present invention lies in the recognition that a  
11 suitable unit may be formed using a much simpler  
12 methodology.

13  
14 Thus, the present invention provides a process for  
15 forming a membrane unit wherein the outer casing is  
16 formed in two casing portions, a membrane is located  
17 within the casing and said casing portions are sealed  
18 together.

19  
20 The present invention also provides a membrane unit  
21 wherein at least two outer casing portions are sealed  
22 together around a membrane. Generally the membrane  
23 unit will be produced by the process described above.

24  
25 The membrane will normally be positioned or shaped to  
26 divide the internal volume of the outer casing into two  
27 discrete areas.

28  
29 The seal between the membrane and the outer casing  
30 portions should be sufficiently tight so that  
31 communication between the two volumes described by the  
32 membrane only takes place by movement of material  
33 across the membrane itself. The seal between the outer  
34 casing portions should be sufficiently tight to prevent  
35 escape of the mother liquor or filtrate at the pressure  
36 at which the filtration is conducted.

1 In one embodiment a bundle of membrane fibres are cut  
2 roughly to length and are placed into a prepared mould.  
3 On closure of the mould the ends of the membrane bundle  
4 are held firmly. A quick-setting adhesive is injected  
5 into the mould close to each end of the membrane fibre  
6 bundle. The mould is formed so that the injected  
7 adhesive forms a plug of pre-determined size and/or  
8 shape close to each end of the membrane bundle. The  
9 adhesive is allowed to set. Preferably the adhesive is  
10 cured by exposure to UV light. Once the adhesive plugs  
11 have set, the membrane bundle is released from the  
12 mould. The exterior end of each plug is preferably  
13 trimmed, for example by use of a sharp knife or  
14 guillotine, which also slices through the membrane  
15 fibres ensuring that the exposed ends of each membrane  
16 fibres are free of cured adhesive. The membrane bundle  
17 is then placed into a pre-prepared outer casing  
18 portion. This casing portion, usually prepared by  
19 thermoforming or casting is adapted so that a tight fit  
20 with the adhesive plugs are formed when the casing has  
21 been completed. The casing portions are adfixed  
22 together, optionally with adhesive, to form a sealed  
23 unit. Instead of using adhesive to complete the outer  
24 casing, the casing portions may be adapted to join  
25 together by a "snap fit" arrangement.

26  
27 The above methodology of producing a plug around the  
28 membrane at a point where the membrane is to be held in  
29 the outer casing may also be used for a single hollow  
30 fibre membrane or for a sheet membrane. For sheet  
31 membranes the step of trimming the membrane and plug  
32 ends may be omitted since such membranes have no lumen  
33 to be blocked by adhesive.

34  
35 In another embodiment the membrane is shaped as a flat  
36 sheet, rather than as a hollow fibre. In this

1     embodiment the flat sheet membrane(s) may be adhered  
2     directly to the outer casing portions, thus dividing  
3     the chamber bounded by the outer casing into two  
4     discrete volumes.

5  
6     The adhesive used in the process of the present  
7     invention may be any adhesive material which does not  
8     react with the membrane or outer casing materials in a  
9     deleterious manner. Preferably the adhesive material  
10    is quick setting, ie cures within minutes, for example  
11    under 5 minutes. For certain embodiments adhesive  
12    material which cures upon exposure to light is  
13    particularly desirable. For example in medical  
14    applications it may be preferred to use adhesive which  
15    cures upon exposure to light, especially blue light or  
16    UV light.

17  
18    Specific mention may be made of light or UV curable  
19    polymers available from Ablestick Ltd (for example LCM  
20    32, LCM 34 and LCM 35), Bostick Ltd or Dynax Inc  
21    (especially 191M) as being useful in this regard.

22  
23    The membrane for use in the device of the invention may  
24    be of any convenient shape and mention may be made of  
25    hollow membrane fibres and flat sheet or tubular  
26    membranes. Hollow membrane fibres or bundles of such  
27    fibres may be preferred in certain situations since  
28    this form permits a relatively large surface area  
29    through which filtration may occur. For other  
30    applications, however, flat membrane sheets (or bundles  
31    of such sheets) may be preferable. The membranes may  
32    contain pores of sizes from 0.001 to 30 microns in  
33    diameter or alternatively may possess Molecular Weight  
34    cut-off values from, for example 100 to 1,000,000 (eg  
35    300 to 100,000, 500 to 1,000) Daltons.

36

1 The membrane may be made of any convenient material and  
2 the present invention is not limited to the membrane to  
3 be used. Generally the membrane will be selected for  
4 the filtration size. Ceramic filters, for example, may  
5 filter particles of diameter 5.0  $\mu\text{m}$  to 0.1  $\mu\text{m}$  and  
6 hollow fibre membranes may filter molecules of 1 mDa to  
7 5 kDa. In suitable membranes are available commercially  
8 and may be made of polysulphone, cellulose, cellulose  
9 diacetate, polypropylene, ceramics materials and/or  
10 other co-polymers.

11  
12 Where the membrane is a ceramics material it is  
13 possible for the tight seal between the membrane and  
14 the outer casing to be formed by use of an "O" ring or  
15 the like formed of suitably resilient material, such as  
16 rubber or plastics.

17  
18 As stated above the outer casing may be formed of any  
19 materials which may be shaped as desired. Generally  
20 therefore a castable or thermoformable material will be  
21 used. As examples, polycarbonate, polypropylene, PVC,  
22 high impact styrene, HDPE and acrylic materials may be  
23 mentioned.

24  
25 Usually the outer casing portions will be shaped to  
26 allow a suitable amount of adhesive to be placed  
27 thereon. Thus, edges will normally have a lip where  
28 joining to another edge is required.

29  
30 Optionally the outer casing portions are shaped to  
31 permit connections with inlet and outlet ports.  
32 Optionally additional inlet/outlet ports (for example  
33 two, three or four additional ports) are present to  
34 enable monitoring of the filtration process or for  
35 inserting a second fluid to control the pressure across  
36 the membrane.

1     Optionally connection tubes are located with the outer  
2     casing portions along with the membrane and a single  
3     adhesion step is used to seal the membrane and outer  
4     casing and also the inlet/outlet connection tubes.  
5     Likewise sensors can be located in position prior to  
6     sealing of the outer casing.

7

8     By way of example embodiments of the invention are  
9     shown in Figures 1-3.

10

11     Figure 1 shows general detail of the construction of  
12     the filter unit. Moulded casing halves 9 and 10 are  
13     sealed together with a UV-activated acrylic sealant to  
14     enclose a hollow fibre bundle membrane unit 11. The  
15     membrane unit 11 is bonded to the outer casing in such  
16     a way that a seal is formed at the ends of the whole  
17     filter cell.

18

19     Figure 2 shows a unit according to the present  
20     invention with outer casing portions 1, 2 and 2'.  
21     Upper outer casing portions 2 and 2' are alternatives  
22     allowing flexible manufacturing capacity. A membrane  
23     bundle 3 is illustrated with cured adhesive plugs 4, 5  
24     at each end thereof. The plugs 4, 5 have been trimmed  
25     at their outer edges so that the end of each hollow  
26     membrane fibre is fully exposed. The adhesive plugs 4,  
27     5 fit snugly into corresponding indentations 6 in the  
28     outer casing portions 1, 2, 2'. To seal the unit  
29     adhesive is smeared onto lip 7 of either or both upper  
30     and lower outer casing portions. Optionally  
31     indentations 6 may also receive adhesive. The membrane  
32     bundle 3 is located in the outer casing portions so  
33     that the plugs 4, 5 are both correctly located in  
34     indentations 6. The outer casing portions 1 and 2 (or  
35     1 and 2' as appropriate) are then aligned and held  
36     together whilst the adhesive sets firmly. The unit is



1     shaped so that a tight seal around each plug 4, 5 is  
2     produced.

3

4     Inlet and outlet ports 8, 9 are also illustrated and  
5     optionally connectors may be affixed thereto. Likewise  
6     side ports 10 are also shown; these enable sampling of  
7     the mother liquor during the process or addition of a  
8     second fluid to the mother liquor, for example to  
9     control the trans-membrane pressure. Alternatively the  
10    side ports may be used to hold a sensor which monitors  
11    the filtration process.

12

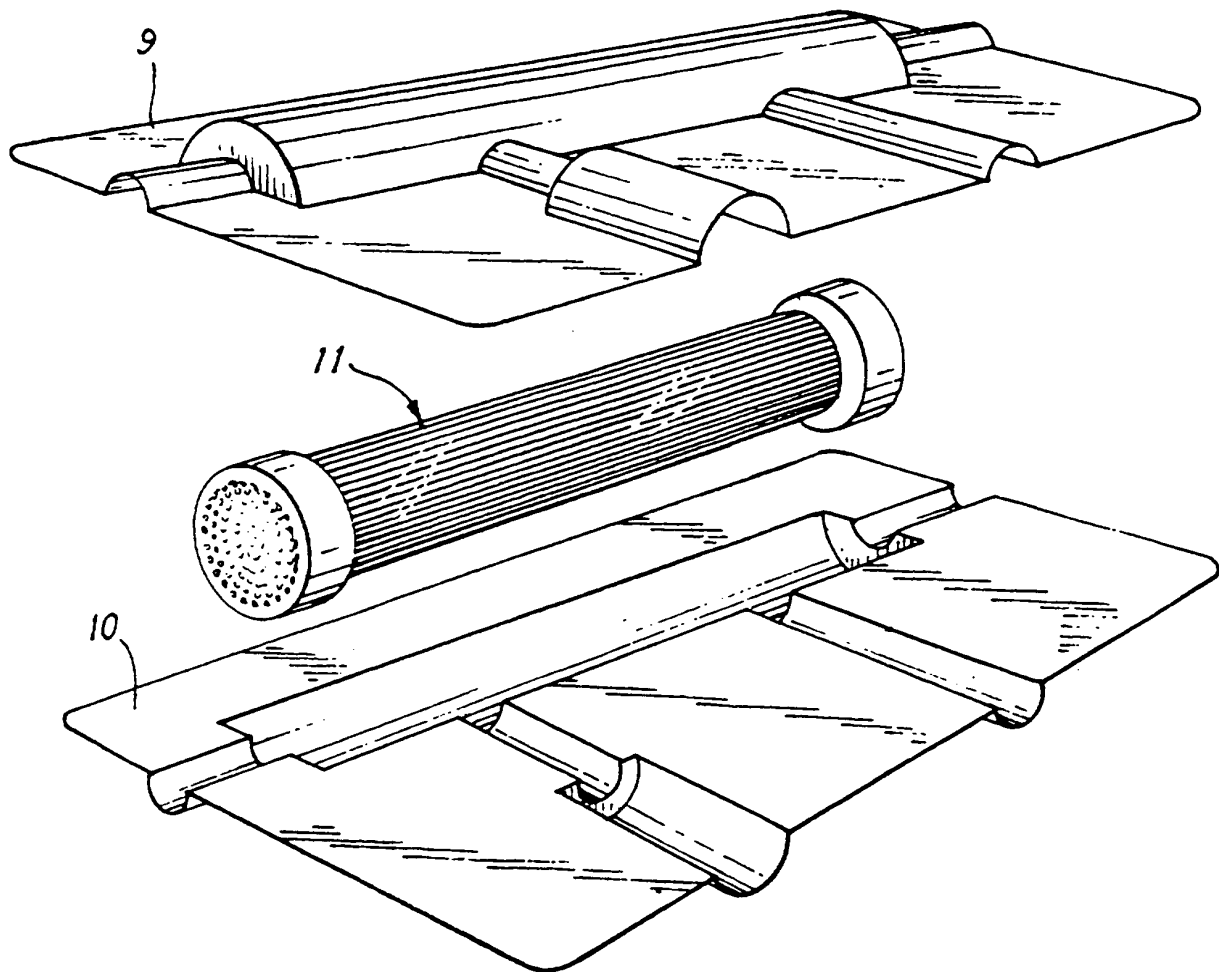
13    Figure 3 illustrates an alternative unit according to  
14    the present invention. This unit is formed as  
15    described for the unit of Figure 2 but the membrane  
16    bundle is bent into a "U"-shape to fit into the outer  
17    casing portions.

18

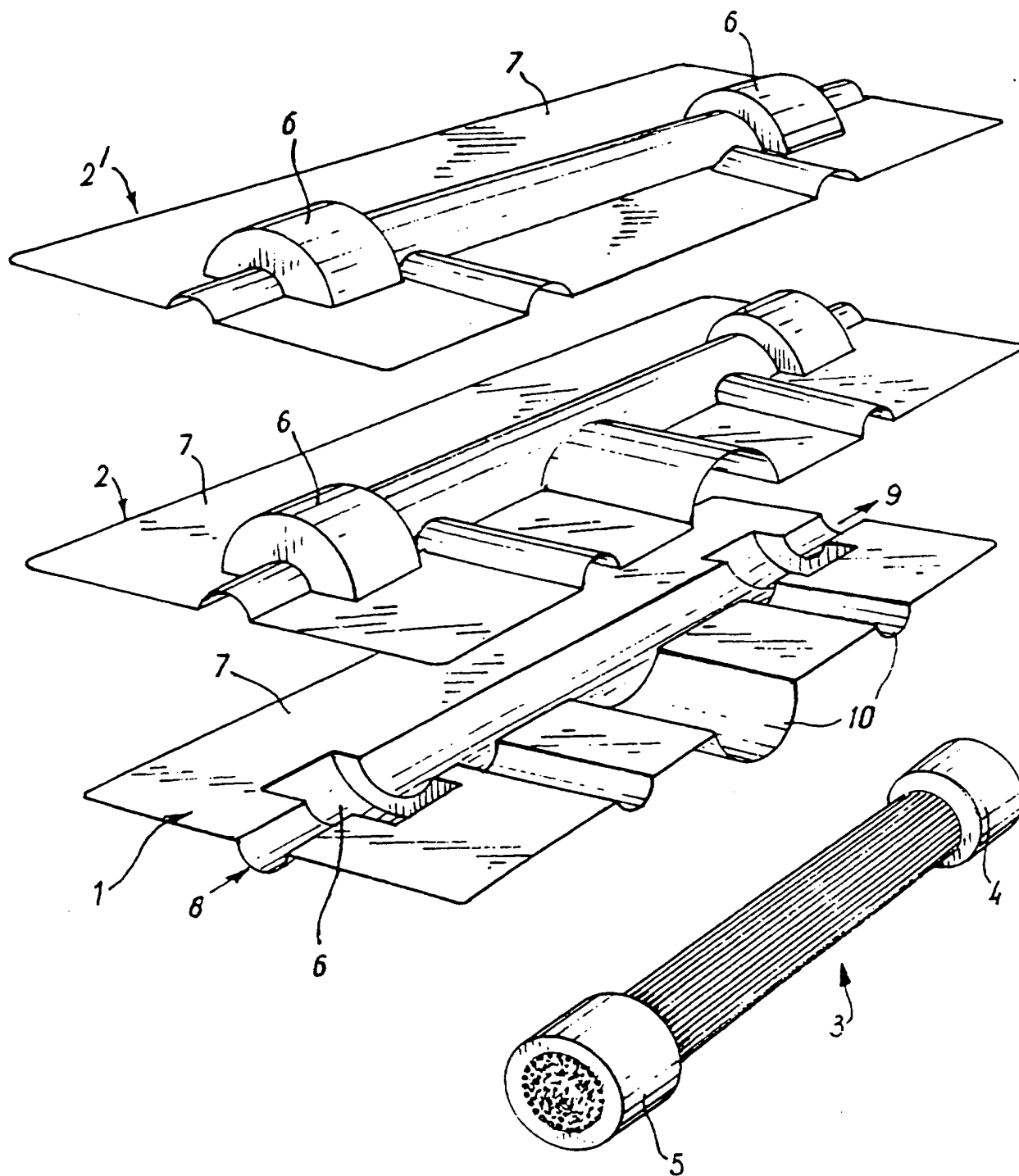
1     Claims

- 2
- 3     1.   A membrane unit wherein at least two outer casing
- 4         portions are sealed together around a membrane.
- 5
- 6     2.   A membrane unit as claimed in Claim 1 wherein the
- 7         membrane is a hollow fibre(s) membrane.
- 8
- 9     3.   A membrane unit as claimed in Claim 1 wherein the
- 10        membrane is a flat sheet membrane.
- 11
- 12    4.   A membrane unit as claimed in any one of Claims 1
- 13        to 3 having at least one additional inlet/outlet
- 14        port.
- 15
- 16    5.   A process for forming a membrane unit wherein the
- 17        outer casing is formed in two casing portions, a
- 18        membrane is located within the casing and said
- 19        casing portions are sealed together.
- 20
- 21    6.   A process as claimed in Claim 5 wherein an
- 22        adhesive plug is formed around the membrane.
- 23
- 24    7.   A process as claimed in Claim 6 wherein the
- 25        adhesive plug is formed from light curing
- 26        adhesive.
- 27
- 28    8.   A process as claimed in either one of Claims 6 and
- 29        7 wherein the ends of the set adhesive plugs are
- 30        trimmed before insertion into the outer casing
- 31        portions.
- 32
- 33    9.   A process as claimed in any one of Claims 5 to 8
- 34        wherein the membrane comprises a hollow fibre
- 35        membrane.
- 36

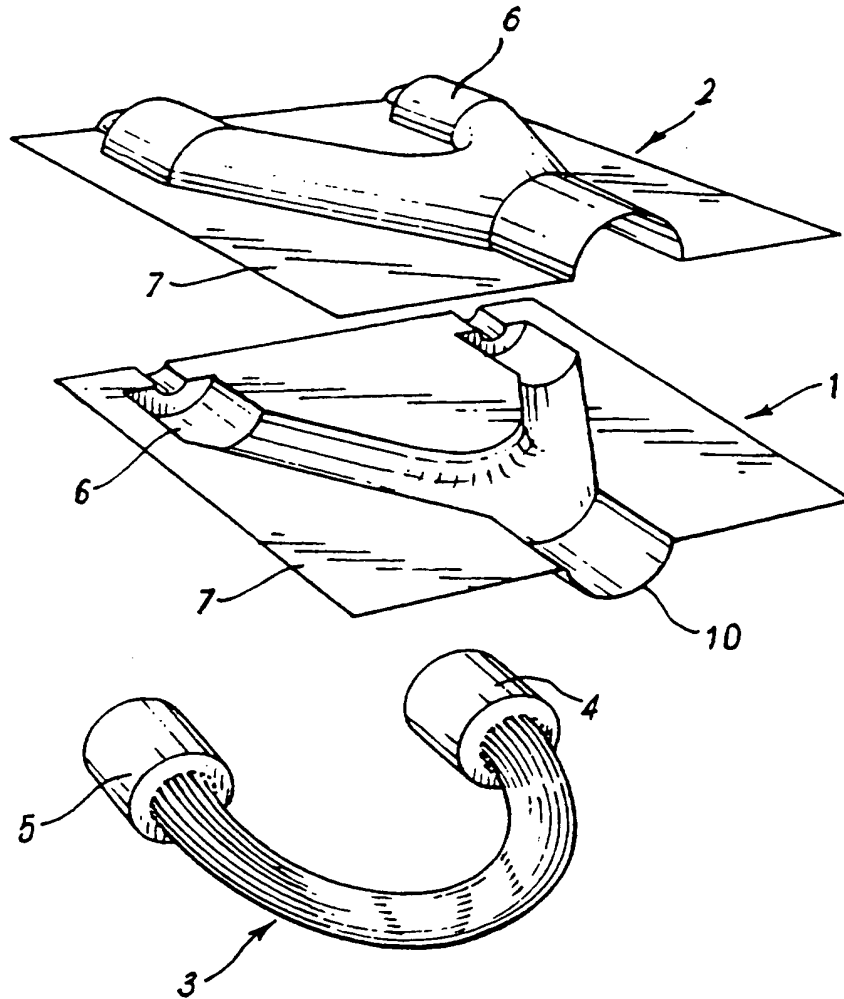
- 1 10. A process as claimed in any one of Claims 5 to 9  
2 wherein the casing portions are sealed together  
3 and to the membrane using light curing adhesive.



**FIG. 1**



***FIG 2***



**FIG. 3**

## INTERNATIONAL SEARCH REPORT

Int. Application No.  
PCT/GB 95/01836

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B01D65/00 B01D63/02 B01D63/08 B01D29/01

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,4 231 871 (B. J. LIPPS ET AL.) 4 November 1980 SEE ESPECIALLY COLUMN 12, LINES 9-29 ---	1
A	AU,A,4 801 972 (THE DOW CHEMICAL CO.) 26 April 1974 SEE ESPECIALLY FROM PAGE 12, LINE 25, TO PAGE 13, LINE 11 ---	1
A	EP,A,0 563 581 (MILLIPORE CORP.) 6 October 1993 see the whole document ---	1
A	US,A,5 011 555 (T. B. SAGER) 30 April 1991 see the whole document ---	1
A	EP,A,0 203 278 (AKZO GMBH) 3 December 1986 SEE ESPECIALLY FIGURES 3 AND 4 -----	

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

30 October 1995

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07 -11- 1995

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.

PCT/GB 95/01836

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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